

REMARKS

The Office Action dated May 15, 2008 has been received and carefully studied.

The Examiner maintains the rejection of claims 1 and 3-8 under 35 U.S.C. §103(a) as being unpatentable over Koyama et al., U.S. Publ. No. 2005/0271922 in view of Kubota et al. for reasons of record. The Examiner did not consider the evidence set forth in the submitted Declarations persuasive.

The Examiner is respectfully requested to reconsider his position.

The Examiner first states that the ion-exchange ability of the polymers derived by the claimed method should be recited in the claims if it is Applicant's objective to prove the unobviousness of their method by illustrating that the other methods do not yield a polymer having this property.

Applicants respectfully disagree. It is Applicant's objective to show that (1) not any sulfoalkylation method may be used, as suggested by Koyama, and (2) the instant method results in unexpectedly superior ion-exchange capacity. In both cases, the property itself need not be recited in the claims. Indeed, the property itself need not even be disclosed in the specification; see MPEP §716.02(f)

and *In re Chu*, 36 U.S.P.Q.2d 1089, 1094-95 (Fed. Cir. 1995) ("We have found no cases supporting the position that a patent applicant's evidence or arguments traversing a §103 rejection must be contained within the specification. There is no logical support for such a proposition as well, given that obviousness is determined by the totality of the record including, in some instances most significantly, the evidence and arguments proffered during the give-and-take of *ex parte* patent prosecution." 36 USPQ2d at 1095).

The Examiner also states that he is unclear as to precisely what Applicants have been attempting to demonstrate with the evidence that has been furnished "as their intent is not explicitly delineated". However, the first full paragraph on page 5 of Applicants' previous response explains that the experiments show that Kubota does not suggest that in the polyethersulfone having the present formula (IV), only the third method disclosed in Kubota can be used. Furthermore, the discussions in the two responses previous to that show that the ion-exchange capacity resulting from the presently claimed method is superior to the ion-exchange capacity using other methods.

More specifically, in the previous responses, evidence was submitted to demonstrate that the present invention has unexpectedly superior effects relative to Koyama and

Kubota. In the second Office Action dated July 20, 2007, the Examiner stated that:

"The Examiner's rejection is predicated on the facts that

(i) Koyama discloses a polymer having, in one embodiment, side chains that are identical to those presently claimed, i.e. where "n" in Formula 1 of the abstract is equal to one,

(ii) Koyama says that any sulfoalkylation method may be employed to prepare the polymers described therein, and

(iii) Kubota describes another synthetic approach for introducing sulfonic acid groups that mirrors the approach being claimed.

A method of making the polymer disclosed by Koyama using the method(s) of Kubota is, therefore, obvious."

Accordingly, Applicants carried out the experiments to show that the sulfonation method of the present invention has unexpected effects.

The Examiner stated in the third Office Action that:

"It is not at all surprising that a product obtained by Applicant when performing this synthesis gave a different NMR spectrum, behaved differently in solution, and yielded a precipitate upon titration because the oxidation of the salt was obviously not complete!"

Accordingly, Applicants carried out the experiments of the third declaration for sulfonation of chloromethylated polyether sulfone to sulfomethylated polyether sulfone by the thiourea method (1) and the EtOCS₂K method (2) in column

7 of Kubota under the conditions disclosed in EXAMPLE 1 and EXAMPLE 2 of Kubota, respectively.

The following table shows the results of experiments that evaluate sulfonation methods:

	Sulfonation method	Ion-exchange Capacity mmol/g (meq/g)	Conversion rate by NMR
Present invention	Reacted with Potassium thioacetate (1hr) to form acetylthio methylated intermediate and then oxidized (8hr)	1.29	100%
Present Comparative Example 1	Reacted with Sodium bisulfite (24hr)	Scarcely Detected	Scarcely Reacted
Embodiment 14 of Koyama (1 st Declaration)	Reacted with Sodium sulfate (5hr)	0.03	
(1) of Kubota (2nd Declaration)	Reacted with thiourea (4hr) to form isothiuronium salt and then oxidized (2hr)	Incapable of measurement	Unidentifiable
(2) of Kubota (2nd Declaration)	Reacted with EtOCS ₂ K (1hr) to form dithiocarbonic acid-O-ethyl ester and then oxidized (2hr)	0.46	Unidentifiable
Macromol. Chem. Rapid. Commun. (2nd Declaration)	Reacted with sodium sulfite and dimethyl sulfide (95hr)	0.01	Unidentifiable
(1) of Kubota (3rd Declaration)	Reacted with thiourea (8hr) to form isothiuronium salt and then oxidized (6hr/12hr)	Incapable of measurement	57% (6hr) 76% (12hr)
(2) of Kubota (3rd Declaration)	Reacted with EtOCS ₂ K (8hr) to form dithiocarbonic acid-O-ethyl ester and then oxidized (6hr)	0.36	Unidentifiable

Although the conversion rates 57% and 76% in (1) of Kubota in the 3rd Declaration are comparatively high, it required very long reaction times and furthermore, more importantly, the products can not use as a polymer for ion-exchange because of decomposition of the remaining isothiuronium salt by an alkali as shown in the third Declaration dated February 28, 2008.

These experimental results show that the sulfonation methods other than the present method, could not give the sulfomethylated polyethersulfone having high ion-exchange capacity capable for use as an ion-exchange polymer. That is, the obtained polymers by the other sulfonation methods had only 0.01 - 0.46 mmol/g (meq/g) of an ion exchange capacity or the ion-exchange capacity of the obtained polymer could not measured. Even the maximum 0.46 mmol/g of the ion exchange capacity is only about 1/3 compared with 1.29 mmol/g (meq/g) of the present sulfomethylated polyethersulfone.

This superior effect is very surprisingly and never suggested by Koyama et al. in view of Kubota et al.

The Examiner also states that there is nothing inventive in evaluating several different known synthetic approaches and selecting the best synthetic approach accordingly. The issue, however, is not whether the

present process is only the selected best synthetic approach from several different known synthetic approaches, but rather is whether the present process is motivated by the prior art and the results are obvious over the prior art.

Although Koyama states that any sulfoalkylation method can be employed to attach sulfoalkyl groups to aromatic hydrocarbon polymer or its polymer alloy (FORMULA 1) (0039), Koyama discloses only three specific sulfoalkylation methods in paragraph [0039-0042], which are: (1) attaching a sulfoalkyl group directly by using sultone, (2) substituting a hydrogen atom of an aromatic ring by lithium, substituting lithium by a halogenoalkyl group by dihalogenoalkane, and converting the halogenoalkyl group into a sulfoalkyl group, and (3) attaching a halogenobutyl group to an aromatic ring by a tetramethylene-halogenium ion and substituting the halogen atom by a sulfonic group.

Both the methods (2) and (3) are methods to convert a halogen atom to a sulfo group and the conversion of a halogen atom to a sulfo group are conducted by sodium sulfate in Embodiments 14 to 15. Other converting methods of halogen atom to sulfo group are nowhere specifically disclosed.

Koyama discloses 13 Embodiments (Embodiments 1 to 13) with respect to the above method (1) (sultone method) and 2 Embodiments (Embodiments 14 to 15) with respect to the methods (2) and (3) (halogen-to-sulfo-converting methods). The 2 Embodiments of halogen-to-sulfo-converting methods are only the method by sodium sulfate mentioned above and other halogen-to-sulfo-converting methods are nowhere disclosed or suggested. Furthermore, Koyama states in 0262 as follows;

"However, the method of producing the sulfoalkylated polyether sulfone electrolyte by sulfoalkylating poly-poly-ether sulfone directly by sultone (as in Embodiment 1) has one process less than the method of Embodiment 14. Therefore, the cost of the sulfoalkylated polyether sulfone electrolyte is two third of the cost of product obtained by the method of Embodiment 14. Namely, the method of sulfoalkylating poly-poly-ether sulfone directly by sultone is lower-costed."

Koyama states that the sultone method is preferable with cost compared with the halogen-to-sulfo-converting methods.

Accordingly, halogen-to-sulfo-converting methods other than the method by sodium sulfate are not motivated by Koyama.

Kubota discloses four methods for converting halogeno(C3-C8)alkyl group on the polymer having structural units represented by formula (I) into sulfo(C3-C8)alkyl group and, as the third synthetic method, the method of

converting halogen atom to sulfo group through thioester (thioester method) is disclosed. However, this polymer having structural units represented by formula (I) is clearly different from the aromatic hydrocarbon polymer compounds having structural units represented by FORMULAE 2-7 of Koyama. Furthermore, details such as reaction conditions or Examples relating to the third synthetic method are nowhere disclosed in Kubota, so that incentives to try the third synthetic method disclosed in Kubota is lacking.

Although Koyama states that any sulfoalkylation method can be employed to attach sulfoalkyl groups to aromatic hydrocarbon polymer or its polymer alloy (FORMULA 1) (0039), as mentioned above, other halogen-to-sulfo-converting methods than the method by sodium sulfate are not motivated by Koyama. Furthermore, in view of the fact that Koyama states that the method of sulfoalkylating poly-poly-ether sulfone directly by sultone is a lower cost method compared with Embodiment 14 which needs two processes of halogenation process and converting process from halogen atom to sulfo group, the thioester method stated in Kubota which needs a still further process (that is, the thioester method needs three processes of

halogenation process, converting process to thioester and further converting to sulfo group), is never motivated.

In such a situation, the present inventors have completed the present invention having surprisingly excellent results mentioned above which have never been achieved by other halogen-to-sulfo-converting methods.

With regard to the rejection of Claim 7, although the Examiner states that "(i) preparation of an acetylthiomethyl-functionalized precursor is certainly disclosed", acetylthiomethyl-poly ether sulfone of claim 7 is nowhere disclosed in either Koyama or Kubota.

Claim 7 is a product claim, that is, polyether sulfone having an acetylthiomethyl group as a substituent on the benzene ring in the bone structure, itself, and not methods as stated by Examiner.

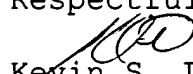
Kubota discloses only the polystyrene represented by the formula (I), which has sulfo(C3-C8)alkyl group, and a production method thereof.

The third synthetic method at the top of column 7 of Kubota describes only about the formation of acetylthio ester intermediate, that is, "(3) ... reacted with CH₃COSH to obtain an acetic thioester and then the product is oxidized ..." in lines 9-11 of column 7. Accordingly, the intermediate products are acetylthio(C3-C8)alkyl-substituted

polystyrene, which is entirely different from the acetylthiomethylated-polyether sulfone of the present claim 7. It is clear that Koyama also nowhere teach or suggest the acetylthiomethylated-polysulfone of the present claim 7.

Reconsideration and allowance are respectfully requested in view of the foregoing.

Respectfully submitted,


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